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THE EXPERIENCE OF THE MONTREAL WATER AND POWER COMPANY IN THE MANUFACTURE OF FILTER ALUM[1]

By James O. Meadows[2]

The filter alum manufacturing plants of Columbus, Ohio, Springfield, Mass., Trenton, N. J., and Omaha, Neb., have been described in detail in *Engineering News Record* of January 4 and 11, 1917. As the general make-up of all Hoover process alum plants is somewhat similar, it is not intended to describe the Montreal Water and Power Company's plant in detail but rather to give the experience of the past four years of operation.

The alum plant was installed with the idea of keeping the capital outlay as low as possible consistent with proper operation, because at the time it was thought that the plant would only be used for a comparatively short period of time. The plant consists of an acid storage tank, a dilute acid tank, bauxite weighing hopper, Stedman mixer, and concrete crystallizing tray. No crusher is provided, the filter alum being broken up into suitable sized lumps by hand sledges.

The manufacture of Hoover process filter alum is simple, but like every simple thing there are several necessary conditions that need to be carried out to secure the product desired. By varying the temperature of the dilute acid the character of the alum can be modified. During the winter months a porous alum is desired, because of its greater solubility, and this product can be obtained by mixing the bauxite with a low temperature acid. During the balance of the year a filter alum of a more dense texture is secured by using a higher temperature acid. The temperature of the crystallizing tray floor is also a factor to be considered, and it is necessary to use a higher temperature acid for Monday's batch because of the lower temperature of the tray floor after the Sunday rest. The temperature of the acid is controlled by agitating it with compressed air and with a cooling coil placed at the bottom of the lead-lined dilute acid tank. By using the air and cooling coil for different periods of time, a dilute acid of the desired temperature can be obtained.

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[1] Read before the Montreal Convention, June 22, 1920. Discussion of this paper is desired and should be sent to the Editor.

[2] Sanitary Engineer, Montreal, P. Q., Canada.

In securing a uniform product from day to day, care must be taken to have the acid strength uniform, the temperature variations slight, and the weight of the bauxite charge correct. The analytical work necessary to control the operation of the alum manufacturing plant consists of the analysis of the bauxite, acid and finished product, and the taking of the specific gravity and temperature of the dilute acid before a batch of filter alum is made.

A batch of alum (approximately 7600 pounds) is made in five mixes, using about one-fifth of the material for each mix and the time consumed in mixing a batch of alum is about three-quarters of an hour. Greater speed in mixing could be obtained if a mixing pan with a deeper pan and two agitators had been installed; also, a better mixture of the bauxite and acid could have been obtained. The batch of alum is usually made early in the afternoon and by the next morning the alum cake is ready to be removed from the crystallizing tray. Before the mixture of bauxite and acid is dumped into the tray, the fine alum dust remaining in the tray is swept up into a ridge extending directly across the tray and to a height of about 2½ inches. When the alum cake is to be removed from the tray, work is started at the alum dust ridge as this point offers an easy place to pry the slabs of alum from the tray floor. The alum cake is removed from the floor with bars and picks and is broken up with hand sledges. The whole process, including carting to the storage floor above, consumes about six hours.

Records of the alum making plant for the past two fiscal years ending May 1 last have been taken off, as during this period the cost of bauxite and acid have been rather constant and it was thought that data covering this period would be fairly representative of present conditions.

The cost of production for this two years' period is as follows:

Bauxite and acid	$45,961
(Including freight and cartage)	
Wages	4,220
Maintenance	1,490
Interest and depreciation, 20 per cent per annum	2,400
Total	$54,071

During this two-year period, 1888 tons of filter alum have been produced, making the cost work out at $28.64 per ton. The market price of commercial filter alum (including freight and duty) during this period has been about $55 f. o. b. Montreal, and, based on this figure, the alum-making plant has shown a saving of slightly more than $49,000 for the two year period. During this time bauxite has cost approximately $24 per ton and 66° Baumé sulphuric acid $26 per ton. At places where these two materials can be purchased at a lower figure the cost per ton for filter alum will also be correspondingly lower, because from the cost data presented it will be noted that the cost of bauxite and acid make up 85 per cent of the total cost.

In the manufacturing of filter alum at the point of consumption, freight, bagging and cartage are saved on the water, which makes up about 20 per cent of the finished product. Experience over a considerable period has shown that the weight of the filter alum produced is practically the same as the combined weight of the materials that go to make up the product.

At the company's water purification plant, the alum solution is pumped to the orifice box and from this point flows by gravity to the point of discharge. Since Hoover process filter alum has been used, greater depreciation of the solution pumps, valves, and fittings has taken place, due to the nature of the insoluble matter contained in the alum solution. This depreciation, however, has not been excessive and has not run into an appreciable figure.

The manufacture of Hoover process filter alum has proved successful for the Montreal Water and Power Company because of the saving effected. A further advantage is also gained, as sulphuric acid is produced within a short distance of Montreal and is easily obtainable, leaving only the bauxite to be secured from a distance, and, when secured, each ton of bauxite in storage represents about three tons of the finished product.

DISCUSSION

A. U. Sanderson: It would be useful to know what percentage of alumina is produced at the plant described in the paper.[3]

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[3] At Toronto an alum containing not less than 17 per cent of available alumina and not more than 0.1 per cent of matter insoluble in cold water, is used. The small quantity of insoluble matter prevents deposits from accumulating quickly in the mixing and constant density chambers and the

William Gore: It will be interesting to learn what effect upon sedimentation has been caused by impurities in the alum in the Montreal operations. This subject was investigated in some detail at the Toronto filtration plant, using a small mechanical filter, and it was found that the best results were obtained with the most impure alum. This sometimes gave 10 or 15 per cent better bacterial removal in the coagulating basin than the commercially pure coagulant gave. While these sedimentation results with impure alum were better the results from filtration were sometimes worse.

James O. Meadows: In the process described in the paper from 17 to 18 per cent of the total product is alumina. At the Montreal plant it is nearer 17 than 18 per cent, because the method of mixing bauxite and acid is not the best possible one.

The impurities in the alum made by the Hoover process will average between 7 and 8 per cent, including insoluble matter. During the early years of operation of the Montreal filters great care was taken to obtain a high-grade commercial alum practically free from iron. Later it was found that in practical operation of the plant with Hoover process alum the water turned out was just as good bacterially as that produced with the less impure alum used originally. Perhaps this maintenance of a high standard is due to greater experience in operating the plant, but it is hardly probable. In experimental work in the laboratory, treating small quantities of water with various strengths of coagulant, the coagulation with Hoover alum has been a little better than that with commercial alum.

connecting pipes, and facilitates operation. A series of laboratory experiments were conducted by N. J. Howard, the bacteriologist in charge of the Toronto Filtration Plant Laboratory, and two distinct grades of alum were applied. In the first group an alum was used containing 17 per cent of alumina and less than 0.3 per cent of insoluble matter, and in the second group the alumina varied between 15 and 17 per cent and contained 10 per cent of insoluble matter. Water was treated with varying quantities of alum ranging between 0.5 and 3 grains per imperial gallon, and was then passed through small sand filters. Throughout the series the results were uniform, the high grade alum giving much higher bacteriological purification.